

## Nematollah (Kayhan) Batmanghelich

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<b>Objective</b>	Building efficient inference and computational tools to elucidate the statistical connections between imaging, genomics, and medical health records, to improve our understanding of human diseases.	
<b>Research Interests</b>	<b>Medical Imaging:</b> Imaging genetics, Computer-aided diagnosis using medical images, Joint modeling of medical images and clinical health records, Computational anatomy. <b>Machine Learning:</b> Deep Learning, Graphical models, Bayesian data analysis, Probabilistic programming, Scalable inference. <b>Optimization:</b> Scalable first-order optimization, Distributed optimization.	
<b>Positions Held</b>	<b>University of Pittsburgh</b> , Pittsburgh, Pennsylvania Assistant Professor, Department of Biomedical Informatics Areas of Research: Imaging Genetics, Machine Learning for Healthcare 9/2016 – present	
	<b>Harvard Medical School</b> , Boston, Massachusetts R25 Research Fellow, Brigham and Women’s Hospital, Department of Radiology Supervisor: Prof. Sandy Wells 9/2015 – 9/2016	
<b>Education</b>	<b>Massachusetts Institute of Technology</b> , Cambridge, Massachusetts Postdoctoral Associate, Computer Science and Artificial Intelligence Lab Advisor: Prof. Polina Golland Areas of Research: Imaging Genetics, Machine Learning 6/2012 – 9/2015	
	<b>University of Pennsylvania</b> , Philadelphia, Pennsylvania PhD in Electrical and System Engineering Advisors: Prof. Christos Davatzikos and Prof. Ben Taskar Thesis: Generative-Discriminative Basis Learning for Medical Imaging Applications 9/2007 – 5/2012	
	<b>University of Tehran</b> , Tehran, Iran MSc in Electrical and Computer Engineering Advisor: Prof. Hamid Soltanian-Zadeh Thesis: Atlas-based Segmentation of Brain Structures Using Deformable Models 9/2002 – 9/2005	
	<b>Amirkabir University of Technology</b> , Tehran, Iran BSc in Biomedical Engineering Advisor: Prof. Ali Motie Nasrabadi Thesis: Application of Fractal Dimension in Detection of Heart Arrhythmia from Cardiophone 9/1998 – 9/2002	
<b>Honors</b>	<b>NVIDIA Best Paper</b> , Machine Learning in Medical Imaging Workshop in MICCAI <b>NIH R25 Fellowship</b> , Computer Assisted Interventions for Cancer Treatment, Brigham Women Hospital <b>Second Place</b> , MICCAI Challenge on Computer-Aided Diagnosis of Dementia based on Struc-	2016 2015

tural MRI Data	2014
<b>M+Vision Grant Fellowship</b> , The Madrid-MIT M+Vision Consortium	2013
<b>Travel Award</b> , 3rd Short Course on Statistical Genetics and Genomics	2013
<b>Top 10 Cited</b> article in NeuroImage in 2008	2008
<b>Top 10 Student Papers</b> , International Symposium on Biomedical Imaging	2011
<b>Student Travel Award</b> , 14th MICCAI conference	2011
<b>Travel Grant</b> , Mathematical Problems, Models and Methods in Biomedical Imaging, Institute for Pure and Applied Mathematics (IPAM)	2010
<b>Ranked 90/~8,000</b> , Nation-wide university entrance exam rank for MSc	2002
<b>Ranked 313/~300,000</b> , Nation-wide university entrance exam rank for BSc	1998

**Invited Talks/ Presentations**

**August 2016:** “Diversifying Sparsity Using Variational Determinantal Point Processes,” Joint Statistical Meetings, Chicago, US.

**June 2016:** “Generative Method to Discover Genetically Driven Image Biomarkers,” International Society for Bayesian Analysis, Sardinia, Italy.

**July 2015:** “Understanding Medical Images Through the Lens of Genetics: a Statistical Modeling Approach,” Imperial College of London, London, UK.

**July 2015:** “Generative Method to Discover Genetically Driven Image Biomarkers,” International Conference on Information Processing in Medical Imaging (IPMI) Conference, Isle of Skye, Scotland (oral acceptance rate: 10%).

**June 2015:** “Understanding Medical Images Through the Lens of Genetics: a Statistical Modeling Approach,” Institute for Advanced Application at Geisinger Health System, Danville, US.

**May 2015:** “Understanding Medical Images Through the Lens of Genetics: a Statistical Modeling Approach,” Statistics in Imaging Section of the American Statistical Association meeting, University of Michigan, Ann Arbor, US.

**March 2015:** “Understanding Medical Images Through the Lens of Genetics: a Statistical Modeling Approach,” Tufts University, Boston, US.

**February 2015:** “Imaging Meets the Genetic World: A Joint Modeling Approach,” Applied Statistics Workshop at Harvard University, Cambridge, US.

**November 2014:** “Imaging Meets the Genetic World: A Joint Modeling Approach,” Computer Science Department colloquium talk, University of Massachusetts, Lowell, US.

**June 2013:** “Joint Generative Modeling of Imaging and Genetics,” International Conference on Information Processing in Medical Imaging (IPMI) Conference, Asilomar, US (oral acceptance rate: 13%).

**July 2013:** “Application of Machine Learning in Medical Imaging,” a short course for *M+Vision Fellows*, Madrid, Spain.

**April 2010:** “Disease Classification and Prediction via Semi-supervised Dimensionality Reduction,” IEEE International Symposium on Biomedical Imaging: From Nano to Macro (ISBI) Conference, Chicago, US.

**April 2010:** “Application of Regularized Low-Rank Decomposition for Feature Construction in Computational Anatomy,” Massachusetts Institute of Technology, Cambridge, US.

**July 2009:** “A General and Unifying Framework for Feature Construction, in Image-Based Pattern Classification,” International Conference on Information Processing in Medical Imaging (IPMI) Conference, Williamsburg, US (oral acceptance rate: 17%).

**Teaching Experience**

- Teaching Assistant for Modern Convex Optimization: 1/2011 – 4/2011  
Delivered lectures in several class sessions, provided office hour support and graded weekly assignments for Modern Convex Optimization (ESE605), University of Pennsylvania.
- Teaching Assistant for Modern Convex Optimization: 1/2009 – 4/2009  
Provided office hour support and graded weekly assignments for Modern Convex Optimization (ESE605), University of Pennsylvania.
- Teaching Assistant for Introduction to Optimization Theory: 9/2008 – 12/2008  
Provided office hour support and graded weekly assignments for Introduction to Optimization Theory (ESE504), University of Pennsylvania.
- Lecturer for “Software Toolbox for Undergraduate Students in EE”: 4/2003 – 5/2003  
Delivered lectures for six-week course about MATLAB, SPICE and some other useful softwares for undergraduate students in Electrical Engineering, Azad University, Shahre-Rey.

- Teaching Assistant for undergraduate course in Microprocessor Lab: 12/2001 – 05/2002  
Provided in-lab support to third year undergraduate students, Amirkabir University of Technology.

## Research Experience

**Massachusetts Institute of Technology**, Cambridge, Massachusetts, USA

*Postdoctoral Associate*

6/2012 – 9/2016

- Computer Science and Artificial Intelligence Laboratory (CSAIL)
  - Constructing a Bayesian model to discover genetic causes of the Alzheimers disease using brain imaging features.
  - Developing a probabilistic model to discover genetically-driven imaging biomarkers for Chronic Obstructive Pulmonary Disease (COPD).
  - Leading a group to develop a distributed optimization method for discriminative pattern learning for COPD using pySpark.
  - Collaborating with Brigham and Women’s Hospital (BWH) on the COPDGene project.
  - Mentoring a student with masters thesis: 3D Texture analysis for characterizing COPD.

**University of Pennsylvania**, Philadelphia, Pennsylvania, USA

*Graduate Student (Research Assistant)*

9/2007 – 5/2012

- Section of Biomedical Image Analysis
  - Developed a generative-discriminative method to reduce dimensionality in medical images for computational diagnosis.
  - Proposed an efficient optimizer for large-scale problems intended for medical imaging applications.
  - Demonstrated a generative model to analyze abnormal brain deformation due to aging, using nuclear-norm and image warping.
  - Released a software package to construct a customizable generative-discriminative matrix decomposition for medical imaging applications.
  - Developed manifold-based multiparametric study of brain images in order to characterize tissue abnormality in normal-appearing brain tissue in Multiple Sclerosis.

**University of Tehran**, Tehran, Iran

*Graduate Student (Research Assistant)*

9/2002 – 12/2005

- Institute for Studies in Theoretical Physics and Mathematics (IPM)
  - Developed an energy-based method built on Simplex-mesh, for 3D segmentation of the Hippocampus-Amygdala complex in brain MR images.
  - Developed an approach based on information fusion to guide deformable models for automatic detection and accurate segmentation of brain structures.
  - Proposed an intelligent medial representation model for structural brain segmentation.

**Amirkabir University of Technology**, Tehran, Iran

*Undergraduate Researcher*

9/2000 – 9/2002

- Summer internship: Designed an algorithm, for the Philips TM1100 4DSP-core processor to perform real-time high-resolution video image affine transformation.

## Professional Experience

**GE Representation in Iran (TPP)**, Tehran, Iran

*Hardware R&D Intern for CT-Scan Section*

9/2003 – 4/2004

- Developed automatic character recognition software for GE workstation without Digital Imaging and Communications in Medicine (DICOM) capability.

## Professional Activities

**Program Committee**

- MICCAI Workshop on Imaging Genetics (MicGen)
- MICCAI Workshop on Medical Computer Vision
- 3rd International Workshop on Pattern Recognition in NeuroImaging (PRNI)
- MICCAI Workshop on Medical Computer Vision

**Journal Reviews**

- Bayesian Analysis

- IEEE Transactions on Medical Imaging
- IEEE Transactions on Pattern Analysis & Machine Intelligence
- IEEE Transactions on Biomedical Engineering
- PLOS Computational Biology
- NeuroImage

#### Conference Reviews

- International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)
- Conference on Neural Information Processing Systems
- IEEE International Symposium on Biomedical Imaging
- Workshop on Mathematical Methods in Biomedical Image Analysis (MMBIA)

## Publicly Available Software

### sHDP

Nonparametric Topic Modeling with Word Vectors. This model enables us to naturally exploit the semantic structures of word embeddings while flexibly discovering the number of topics.

Distributed via: <https://github.com/kayhan-batmanghelich/sHDP>

Role: Developer

### GONDOLA

This software provides a generative method to reduce the dimensionality of medical images in a clinically interpretable yet discriminative way.

Distributed via: <http://www.rad.upenn.edu/sbia/software/gondola/>

Role: Developer

### BASIS

This is a development environment library with accompanying tools for testing and packaging software across platforms and languages.

Distributed via: <http://www.rad.upenn.edu/sbia/software/basis/>

Role: Tester, Developer

## Publications

1. J. Schabdach, S. Wells, M. Cho, **N. Batmanghelich**, A Likelihood-Free Approach for Characterizing Heterogeneous Diseases in Large-Scale Studies. *International Conference on Information Processing in Medical Imaging (IPMI)*, to be appear in LNCS, 2017.
2. O. Freifeld, S. Hauberg, J. Fisher III, **N. Batmanghelich**, Transformations Based on Continuous Piecewise-Affine Velocity Fields. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 2017.
3. **N. Batmanghelich**, A. Saeedi, R. J. Estepar, M. Cho, S. Wells, Inferring Disease Status by non-Parametric Probabilistic Embedding. *Workshop on Medical Computer Vision: Algorithms for Big Data (MCV), Held in Conjunction with International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, to be appear in LNCS, 2016.
4. P. Binder **N. Batmanghelich**, R. J. Estepar, P. Golland, Unsupervised Discovery of Emphysema Subtypes in a Large Clinical Cohort. *7th International Workshop on Machine Learning in Medical Imaging (MLMI), Held in Conjunction with International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, LNCS, pp 180-187, 2016.
5. **N. Batmanghelich**<sup>†</sup>, A. Saeedi<sup>†</sup>, K. Narasimhan, S. Gershman, Nonparametric Spherical Topic Modeling with Word Embeddings. *Proceedings of the 54th Annual Meeting of the Association for Computational Linguistics (ACL)*, pp 537-542, 2016.
6. **N. Batmanghelich**, A. Dalca, G. Quon, M. Sabuncu, P. Golland, Probabilistic Modeling of Imaging, Genetics and the Diagnosis. *IEEE Transactions on Medical Imaging (TMI)*, pp 1765-1779, 2016.
7. O. Freifeld, S. Hauberg, **N. Batmanghelich**, J. Fisher III, Highly-Expressive Spaces of Well-Behaved Transformations: Keeping It Simple. *Proceedings of the IEEE International Conference on Computer Vision (ICCV)*, pp 2911-2919, 2015.
8. **N. Batmanghelich**<sup>†</sup>, A. Saeedi<sup>†</sup>, M. Cho, R. J. Estepar, P. Golland, Generative Method to Discover Genetically Driven Image Biomarkers. *International Conference on Information Processing in Medical Imaging (IPMI)*, LNCS 9123, pp 30-42, 2015.
9. **N. Batmanghelich**, M. Cho, R. Estepar, P. Golland, Spherical Topic Models for Imaging Phenotype Discovery in Genetic Studies. *Workshop on Bayesian and Graphical Models for Biomedical*

imaging, *International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, LNCS 8677, pp 107-117, 2014.

10. C. Wachinger, **N. Batmanghelich**, P. Golland, M. Reuter, BrainPrint in the Computer-Aided Diagnosis of Alzheimer's Disease. *Challenge on Computer-Aided Diagnosis of Dementia. International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, 2014.
11. **N. Batmanghelich**, A. Dalca, M. Sabuncu, P. Golland, Joint Modeling of Imaging and Genetics. *International Conference on Information Processing in Medical Imaging (IPMI)*, LNCS 7917, pp 766-777, 2013.
12. Y. Ghanbari, L. Bloy, **N. Batmanghelich**, R. Verma, Dominant Component Analysis of Electrophysiological Connectivity Network. *International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, pp 231-238, 2012.
13. **N. Batmanghelich**, B. Taskar, C. Davatzikos, Generative-Discriminative Basis Learning for Medical Imaging. *IEEE Transactions on Medical Imaging (TMI)*, 31(1), pp 51-69, 2012.
14. L. Bloy, M. Ingalhalikar, **N. Batmanghelich**, An integrated Framework for High Angular Resolution Diffusion Imaging-Based Investigation of Structural Connectivity. *Brain Connectivity*, 2(2), pp 69-19, 2012.
15. **N. Batmanghelich**, B. Taskar, C. Davatzikos, Regularized Tensor Factorization for Multi-Modality Medical Image Classification. *International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, pp 17-24, 2011.
16. **N. Batmanghelich**, D. Ye, B. Taskar, C. Davatzikos, Disease Classification and Prediction via semi-supervised Dimensionality Reduction. *IEEE International Symposium on Biomedical Imaging: From Nano to Macro (ISBI)*, pp 1086-1090, 2011.
17. **N. Batmanghelich**, A. Gooya, B. Taskar, C. Davatzikos, Application of Trace-Norm and Low-Rank Matrix Decomposition for Computational Anatomy. *IEEE Computer Society Workshop on Mathematical Methods in Biomedical Image Analysis (MMBIA), Computer Vision and Pattern Recognition Workshops (CVPRW)*, pp 146-153, 2010.
18. C. Davatzikos, P. Bhatt, L. Shaw, **N. Batmanghelich**, J. Trojanowski, Prediction of MCI Conversion via MRI, CSF Biomarkers, and Pattern Classification. *Neurobiology of Aging*, 32(12), pp 2322.e192322.e27, 2010.
19. **N. Batmanghelich**, B. Taskar, C. Davatzikos, A General and Unifying Framework for Feature Construction, in Image-Based Pattern Classification. *International Conference on Information Processing in Medical Imaging (IPMI)*, LNCS 5636, pp 423-434, 2009.
20. Y. Fan, **N. Batmanghelich**, C. Clark, C. Davatzikos, Spatial Patterns of Brain Atrophy in MCI Patients, Identified via High-dimensional Pattern Classification, Predict Subsequent Cognitive Decline. *NeuroImage*, 39(4), pp 1731-43, 2008.
21. **N. Batmanghelich**, R. Verma, On Non-linear Characterization of Tissue Abnormality by Constructing Disease Manifolds. *IEEE Computer Society Workshop on Mathematical Methods in Biomedical Image Analysis (MMBIA), Computer Vision and Pattern Recognition Workshops (CVPRW)*, pp 1-8, 2008.
22. H. Shariatpanahi, **N. Batmanghelich**, A. Kermani, M. Ahmadabadi, H. Soltanian-Zadeh, Distributed Behavior-based Multi-agent System for Automatic Segmentation of Brain MR Images. *International Joint Conference on Neural Networks (IJCNN)*, pp 4535-4542, 2006.
23. **N. Batmanghelich**, H. Soltanian-Zadeh, B. Aarabi, Knowledge-based Segmentation: Using Simultaneous Shape Prior and Histogram Information to Segment Brain Structures. *IASTED Conference on Signal and Image Processing*, pp 15-17, 2005.
24. M. Karimi, **N. Batmanghelich**, H. Soltanian-Zadeh, C. Lucas, A 3-D Deformable Surface Method for Automatic Hippocampus-Amygdala Complex Segmentation. *IEEE Nuclear Science Symposium Conference Record*, 6, pp 3725-3729, 2004.
1. **N. Batmanghelich**, G. Quon, A. Kulesza, M. Kellis, P. Golland, L. Bornn, Diversifying Sparsity Using Variational Determinantal Point Processes. *arXiv preprint arXiv:1411.6307*, 2014.

Reports/  
Under Review